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Excessive endotracheal tube cuff pressure: Is there any difference between emergency physicians and anesthesiologists?

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ABSTRACT

Introduction. Endotracheal tube (ETT) cuff pressure is not usually measured by manometer and the providers rely on their estimation of cuff pressure by palpating the pilot balloon. In this study, we evaluated the pressure of ETT cuffs inserted by emergency physicians or anesthesiologists, and assessed the accuracy of manual pressure testing in different settings using a standard manometer.

Methods. In this cross sectional study, the cuff pressure of 100 patients in emergency department (ED) and intensive care units (ICU) of two university hospitals was evaluated by using a sensitive and accurate analog standard manometer after insertion of the ETT and checking the pilot balloon by the provider. All measurements were performed by a person who was blinded to the study purpose and an ideal pressure range of 20 to 30 cmH_2O was used for analysis.

Results. Emergency physicians (n=58) and anesthesiologists (n=42) performed the intubations. The mean measured cuff pressure in our study was 69.2±29.8 cmH_2O (range: 10-120 cmH_2O) which was significantly different from the recommended standard value of 25 cmH_2O (P<0.0001, one-sample t-test). No difference was found between anesthesiologists and emergency physicians in cuff inflation pressures (Anesthesiologists = 71.1 ± 25.7; Emergency physicians = 67.9±32.6).

Conclusion. Estimation of cuff pressure using palpation techniques is not accurate. In order to prevent adverse effects of cuff overinflation, it is better to recheck the pressure using a manometer, regardless of place, time and the inserter of the endotracheal tube.

Key words: endotracheal tube, cuff pressure, emergency physicians, anesthesiologist

Introduction

Endotracheal tube (ETT) cuff pressures are not routinely measured and previous studies have shown that cuff palpation is not sufficient to detect high cuff pressures. (1,2) Despite manual control of the cuff pressure by feeling the pilot balloon, overinflation of the endotracheal cuff is commonly reported in intensive care unit patients. (1,3) Overinflation of the ETT cuff is an avoidable risk factor for tracheal ischemia and subsequent complications. During cuffed intubation, excessive pressure on the tracheal mucosa, more than mean capillary perfusion pressure of the mucosa, leads to tracheal damage and pathologic changes such as ischemia, inflammation, ulceration, tracheal necrosis or stenosis and tracheoesophageal fistula. (4-8) Endoscopic studies have shown a relationship between elevated cuff pressures and tracheal lesions (5) and it is reported that respiratory complications such as cough, sore throat, hoarseness, and blood-streaked expectoration would occur even following short duration intubations (1-3 hours). (9) Although some articles propose a pressure as high as 40 cmH_2O of ETT cuff pressure (which is equal to tracheal capillary pressure) for initiation of mucosal damage, (1,10) it is recommended to maintain the cuff pressure within a narrow ideal range of 20 to 30 cmH_2O to prevent complications. (11-13) There has been little or no study of intracuff pressures among patients intubated in the emergency department (ED) by emergency physicians. In this study, we evaluated the pressure of ETT cuffs inserted in different hospital wards and by emergency physicians or anesthesiologists, and

Table 1. Study sample characteristics (n= 100).

Patients' gender (%) (M/F)	34/66	
ED/ICU (%)	58/42	
Patients' age (year) (mean ± SD)	57.8 ± 20.4	Range: 18-94
Intubation-measurement time (min) (mean ± SD)	42.6 ± 48.5	Range: 1-168
Cuff pressure (cm H_2O) (mean ± SD)	69.2 ± 29.8	Range: 10-120

ED, Emergency Department; F, female; ICU, Intensive Care Unit; M, male; SD, Standard Deviation.

assessed the accuracy of manual pressure testing in different settings using a standard manometer.

Materials and Methods

In this cross sectional study, the cuff pressure of 100 patients in ED and intensive care units (ICU) of two university hospitals from October 2010 to April 2011 were evaluated by using a standard manometer.

Study Population

Patients above 18 years of age who were intubated by high volume, low pressure endotracheal tubes, in ICU and ED of Hazrat Rasoul Akram and Haft-e Tir medical centers of Tehran University of Medical Sciences (TUMS), Iran, entered the study, regardless of the indication. The patients were selected using a convenience sampling method. The internal diameter of the endotracheal tubes ranged from 7.0 to 9.0 mm. Other inclusion criteria were: intubation by someone other than the authors, and having no previous history of tracheotomy, laryngeal disease or surgery.

Methods

After insertion of the ETT by an emergency physician or anesthesiologist, 5-10 cc of air was used to inflate the pilot balloon and it was palpated to ensure it had sufficient pressure to prevent air leak and fluid aspiration into the lungs. In order to measure endotracheal tube cuff pressure, a standard hand-held analogue manometer manufactured by Mallinckrodt (West Germany) was used. Pressure measurement was performed through the connection of the analogue manometer to the pilot balloon. All measurements were done using a single manometer, and this manometer was calibrated routinely every three days.

To avoid measurement bias, just one person performed all measurements and he was blinded to the intubation process: the indication, the time and the person who had placed the tube. After measurement of the cuff pressure, the pressure was adjusted to an acceptable level (25 cmH_2O).

Data collection tools

All collected data, about the patients and the cuff pressure values, were entered into a data collecting form. The age and sex of the patients, and also the time between the endotracheal tube insertion and pressure measurement were also recorded.

Statistical methods for the data analysis

For statistical analysis, SPSS version 17 (Statistical Package for Social Sciences, SPSS Inc, Chicago, Illinois, U.S.A.) software was used. Descriptive data are presented as means and standard deviation. A sample t test was used to compare the mean cuff pressure value with the standard recommended value and one way ANOVA was used to compare means. Every reported P-value is based on two-sided tests and compared to a significance level of 5%.

Considering the research ethics

Table 2. Intubation data in two medical centers according to practitioner.

	N (%)	Age (years) (mean ± SD)	Time (min) (mean ± SD)	Pressure (cm H_2O) (mean ± SD)
Haft-e Tir	54	51 ±20.4	52.6 ± 49.6	69.8 ±28.4
EP	25	54.0 ± 18.2	30.2 ± 46.4	69.8 ±31.8
AN	29	48.4 ±22.1	71.9 ±44.3	69.9 ±25.7
Hazrat Rasoul Akram	46	65.8 ±17.4	30.8 ± 43.9	68.5 ±31.7
EP	33	67.1 ±16.6	13.9 ±24.9	66.5 ±33.7
AN	13	62.5 ±19.6	73.7 ±52.7	73.7 ±26.6
Sig. (2-tailed)		> 0.05	> 0.05	> 0.05

AN, Anesthesiologist; EP, Emergency Physician; SD, Standard Deviation.

Table 3. Mean cuff pressure and % of overinflation.

Author	N	Provider *	Normal Range (cm H_2O)	Mean	% of Overinflation
Stewart (4)	40	NAS,CRNA,A	25-40	44.5±13.07	65 (>40 cm H_2O)
Parwani (16)	23	paramedic students	<25	>98	? (70% > 120 cm H_2O)
Hoffman (8)	67	EMR,EP	15-25	EMP >93 EMR >106	? (0.4 in normal range)
Svenson (10)	62	HP,AP	14-27	63 ±34	58 (>40 cm H_2O)
Sengupta (13)	93	Anesthesiologists	20-30	35.3 ±21.6	27 (>40 cm H_2O)
Galinski (2)	107	Not identified	14-27	Out of Hospital: 56±34 Transferred Pts: 69±37	79 (>27 cm H_2O)

A, Anesthesiologists; AP, Ambulance Personnel; CRNA, Certified Registered Nurse Anesthetists; EMR, Emergency Medicine Residents; EP, Emergency Physicians; HP, Helicopter Physicians; NAS, Nurse Anesthesia Students.

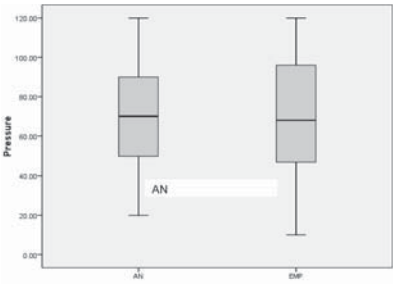

Figure 1. There was no difference between the mean cuff pressures inserted by two practitioner groups (AN, Anesthesiologists; EP, Emergency physicians).

The Ethics Committee approved the study and all patients' data remained totally confidential. After recording the measurement, cuff pressure was adjusted to within normal range, if needed.

Results

Demographic data

A total of 100 intubated patients were investigated in our study. Among these, 46 were from Hazrat Rasoul Akram hospital and the remaining 54 were from Haft-e Tir medical center (table 1). In total, 34% (n=34) of patients were female and 66% (n=66) were male. The patients' mean age was 57.8±20.4 years. Demographic characteristics of the patients were similar at both hospitals. There was no correlation between the measured cuff pressure and the age and sex of the patients.

Intubation data

Emergency physicians (n=58) and anesthesiologists (n=42) performed the intubations. The average intubation period to the cuff pressure measurement was 42.6±48.5 minutes. The mean measured cuff pressure in our study was 69.2±29.8 cmH_2O. Endotracheal tube cuff pressure was higher than the tracheal capillary pressure (>40 cmH_2O) in 83% of patients and only 6% of the patients had measured pressures within the recommended range of 20–30 cmH_2O. This measured mean cuff pressure was significantly different from the recommended standard value of 25 cmH_2O (P<0.0001, one-sample t-test). Statistical analysis showed that there was no difference between the mean cuff pressures in two hospitals and their different wards (ICU or ED) (P=0.828; One-way ANOVA, table 2). There were no statistically significant differences in measured cuff pressures among the two practitioner groups (Anesthesiologists = 71.1 ± 25.7; Emergency physicians = 67.9±32.6) (P = 0.828; Independent Samples T Test, figure 1).

Discussion

Emergency medicine specialists and anesthesiologists are primarily responsible for airway management and most intubations are done directly by them or under their supervision. It is believed that trained clinicians can prevent overinflation of ETT cuffs by palpation of ETT pilot balloons but there are reports that students' or nurses' abilities were similar to more trained or experienced groups (1,4,14) and most of the practitioners are not able to estimate correctly without using a precise manometric measurement (table 3). As high volume low pressure cuffs make greater contact with the tracheal mucosa and apply a lower pressure against the tracheal wall, the risk of tracheal wall ischemia or necrosis will decrease. These cuffs are claimed to have less adverse effects on tracheal mucosa than high pressure, low volume cuffs. (6) However, low pressure cuffs may easily be overinflated to pressures that exceed capillary perfusion pressure. (12) Our study demonstrates that emergency physicians and anesthesiologists overestimated safe inflation pressures, regardless of time and place of measurement of endotracheal tube cuff pressure. This implies that this is not a skill that can be achieved over time or with training or experience.

Limitations

It should be remembered that as part of the limitations of a cross-sectional study, factors such as the volume of the gas used to inflate the cuff, tracheal diameter, pressure changes within the thorax, (4) changes in body position in patients under mechanical ventilation, (15) and many other confounding factors which could interfere with cuff pressure and the amount of pressure the cuff exerts against the tracheal wall, were not evaluated, and designing a more comprehensive study to realize all aspects of using endotracheal tubes is reasonable.

Conclusion

This study revealed that 94% of measured cuff pressures did not fall within the safe pressure range and required correction. It seems that endotracheal tube cuff pressures should be routinely measured by standard manometers not only to reduce long-term morbidity of the trachea and surrounding structures, but also to prevent aspiration of pharyngeal contents into the trachea during positive pressure ventilation.

As measurement of endotracheal cuff pressure is a simple and cost-effective procedure, we recommend that ETT cuff pressures be measured and adjusted intermittently whenever a patient is intubated in all hospital settings.

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